The Quahog

The following synopsis of the life history of the hard clam or quahog, *Mercenaria mercenaria*, has been extracted from Barnes (1974), Fiske (1981), Loosanoff et al. (1951), and Shuster (1971) unless otherwise noted. This summary is relevant to environmental conditions prevalent in Waquoit Bay and adjacent waters. This detailed account provides an insight to the delicate nature of the quahog that is not casually obvious.

"Quahog" (or quahaug) is a native American name for the hard clam (Fig. 4.3), but in popular use it refers to only the largest size class. Generally, "cherry stone" identifies the mid-range size class and "littleneck," the smallest (legally harvestable) size class. There are exceptions to this nomenclature, however. For example, in Connecticut, cherry stone and littleneck are reversed (i.e., cherry stone is the smallest). (Throughout this account the term quahog will be used as the name for this animal, without any implication to age or size.)

Spawning and Embryonic Development

Most quahogs spawn in early summer, but some may continue into the fall (Diamond 1981). They release millions of eggs and sperm from their exhalant siphons into the water column where fertilization occurs quickly. A free-swimming trochophore larva develops within about 12 hours, and by the time it is about 24 hours old, the trochophore has become a veliger larva. The rate of this development depends on salinity, temperature and type of food available (Davis and Calabreese 1964). The larva drifts in the tides with the plankton, and is swept around (and may be out of) the Bay depending on circumstances.

The veliger is a suspension feeder, and its characteristic organ, the velum, consists of two semicircular lobes bearing long cilia. Cilia are extremely delicate structures susceptible to various agents of water pollution. Because of their important functions and susceptibility to environmental insult, a detailed discussion of the roles cilia play in various phases of the quahog's life cycle follows.

The long cilia of the velum beat rhythmically and produce water currents. This action filters food from the water by bringing phytoplankton into contact with a mucus sheet. This sheet is passed on by shorter cilia to the mouth where the food enters for the processes of digestion and assimilation.

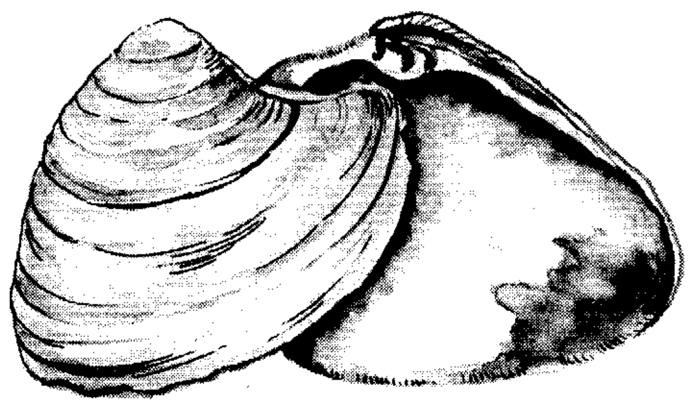

Figure 4.3
Shells of the quahog, Mercenaria mercenaria. *Drawing by Caroline Goldstein.*

Although the veliger is truly planktonic, the beating cilia of the velum also function in locomotion. By altering the rhythm of beating cilia, the veliger can adjust its depth in the water column as it searches for the appropriate temperature, salinity, light level, etc. It may remain in the water column for two weeks and experience different microenvironments of varying salinity and quality. During this time it may drift considerable distances from the place it was spawned.

Metamorphosis

During the planktonic phase, growing mantle tissue forms a shroud around the veliger in the form of bivalve shells. Further growth increases the weight of the veliger until it can no longer maintain its position in the water column. It settles to the bottom, alternately swimming and then creeping along on the substrate.

Eventually, metamorphosis is completed by the shedding of the velum. The young quahog then propels itself along the bottom with its strong, recently developed protractile foot. At this stage it is about 200 microns (0.008 inch) in length and it can still get swept along by tides. With the loss of the velum, feeding is now accomplished by cilia on the surface of sheet gills in the newly formed mantle cavity. Cilia move water from the incurrent siphon to the gills, possibly at a rate proportional to the quahog's requirement for oxygen (Hamwi and Haskin 1969; Van Winkle 1975). At the gills a complex arrangement of cilia filter out waterborne food particles. These are subsequently entangled in a mucus layer and passed to a food groove leading to the labial palps surrounding the mouth. Particles too large or heavy are sorted by various ciliated mechanisms and are not passed on to the food groove. They are eventually ejected from the mantle cavity.

The outer surface of the mantle has now become covered by a smooth calcareous shell which thickens and protects the young quahog. Glandular secretions of byssal threads temporarily anchor the young quahog to the substrate. It alternates crawling for short distances with periods of byssal attachment to sand grains or other surfaces. This period of benthic excursions is brief. After mantle tissue has fused into functional siphons, the quahog ceases to produce byssal threads and begins to burrow into the sediments by periodically extending and expanding its muscular foot. Whereas it once maintained its position on the surface by its byssus, it now has developed ridges on its newly formed shell and these enhance its ability to remain lodged in the sediment. It is now about 9 mm (0.35 inch) long.

Environmental Requirements

The quahog is dioecious (separate sexes) and reaches sexual maturity in about three years. It is capable of adapting to broad ranges of DO (Walsh 1974)and salinity (Wells 1961). It can be found in virtually all parts of Waquoit Bay in all types of bottom including gravel, sand, and mud. Thus, quahog habitat may be difficult to define (Saila et al. 1967). But because fine sediments interfere with ciliary mechanisms, the quahog does not thrive in bottoms dominated by finer particles (Pratt 1953; Stickney and Stringer 1957).

Growth

Growth rates vary in different bottom types (Pratt 1953)and also in similar bottom types in different locations (R. Crawford, unpub. data). It has been reported that water movement, which influences a benthic organism's food supply, is a potent factor affecting shellfish growth (Ryther 1969). As noted above, growth is also affected by fine suspended sediments that interfere with ciliary selection of food particles (Rhoads and Young 1970).

Quahogs live 30 years or more (Hall 1979) and 20-year old quahogs are not uncommon even in heavily fished areas. Shuster (1971) reported a maximum size of 15.6 cm (6.125 inch long) at 1.1 kg (2.5 pounds) live weight and Bricelj (1979) found no evidence to suggest that egg production declines with increasing age. However, Bricelj (1979) did allow that smaller size classes probably contribute the larger proportion to total population fecundity because they are dominant in numbers.

Burrowing Behavior

Quahogs burrow in the sediments both vertically and horizontally (Ansell 1962). They can sometimes be found within a centimeter of the surface; occasionally they are partially or completely exposed. Most often, they are buried deeper. They have been recorded at depths to 9.2 cm (3.6 inches) (Ansell 1962), and it is commonly believed by local fishermen that quahogs burrow deeper in the winter than in the summer. Very dense beds of quahogs which have burrowed to various depths appear to be arranged in layers, one on top of the other (R. Crawford, pers. obs.). Quahogs also move along the surface of sediments, most frequently during their early development but occasionally later.

Mortality and Predation

Perhaps only one out of 29 million eggs survives to become a legal size clam (Bricelj 1979). While predation can be considered to be responsible for only a portion of that loss, oyster drills, *Eupleura caudata*, *Urosalpinx cinerea*, and *Neopanope texana*, can be very destructive of young quahogs (Stickney and Stringer 1957). Other important predators include the horseshoe crab, *Limulus polyphemus*; blue crab, *Callinectes sapidus*; calico or lady crab, *Ovalipes ocellatus*; spider crab, *Libinia emarginata*; lobed moon shell, *Polynices duplicata*; channelled whelk, *Busycon canaliculatum*; "black-fingered" mud crabs, such as *Neopanopeus sayi*; the knobbed whelk, *B. carica*; and the common sea star, *Asterias forbesi*; all of which are common in Waquoit Bay.

Fish also prey on young quahogs. Winter flounder, *Pleuronectes americanus*, (Medcof and MacPhail 1952; Frame 1972), summer flounder, *Paralichthys dentatus*, and tautog, *Tautoga onitis* (MacKenzie 1977) are all known to include quahogs in their diet, and they too are common in Waquoit Bay. Other fishes such as the cunner, *Tautogolabrus adspersus*, are not as well studied but may also compete with people for a meal of this delicately flavored shellfish. Alteration of quahog predation may represent an area of significant potential in increasing natural production, (MacKenzie 1979a; 1979b; Carter et al. 1984). However, it is not known if it is practically and economically possible to alter the impact of predators by mechanical means.

Another avenue of unresolved research is the elucidation of a methodology for identifying the location of brood stocks within coastal waters. In some areas, a portion of the quahog population is protected from harvesting because of restrictions due to public health hazards (e.g. shellfish bed closures due to high fecal coliform counts). Conrad (1981) has suggested that these protected populations may contribute seed to heavily fished beds in clean waters and may constitute the major reason why many beds sustain a high level of exploitation without becoming more severely depleted.

Similarly, quahog fisheries may be sustained by beds occurring in gravel bars along the shore where the coarse substrate is difficult to dig. Gravel also protects quahogs from predators such as sea stars, crabs, and predatory snails. The same can be said of beds of large (i.e. commercially less desirable) quahogs in the open basins covered with seagrass or seaweed. These beds are less accessible because the water is deeper and the plants quickly foul a shellfisherman's rake, making fishing difficult. (Unfortunately, some fishermen uproot eelgrass to gain access to shellfish, a damaging and short-sighted practice.) The contribution of the quahog resources in these places to the overall health of a fishery is unknown but may be significant.

A practical methodology for identifying natural sources of quahog spat would be a powerful management tool for sustaining valuable quahog fisheries. Research in this area has valuable implications in issues of coastal zone management (e.g., shoreline alterations and boating impacts).